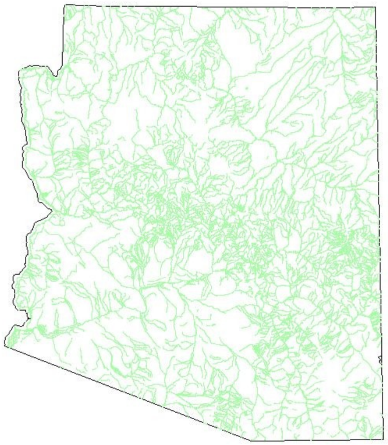
# "A CASE STUDY OF THE ASSESSMENT OF ECOSYSTEM RESTORATION USING HGM"

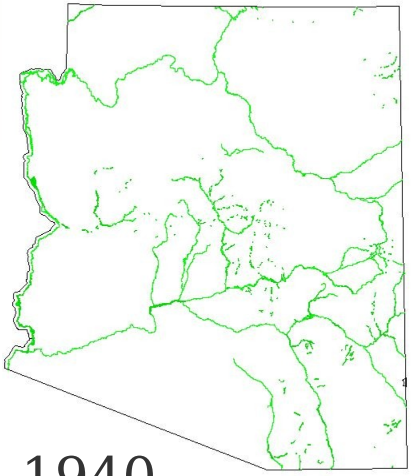
EL RIO ANTIGUO • RILLITO RIVER

**"I have always noticed, and it is a fact, that often we have something valuable in our possession and handle it freely, we do not esteem or appreciate it in all its worth, as we would if we could realize how much we would miss it if we were to lose it. Thus we gradually belittle its value, but once we have lost it and miss its benefits, we feel it in our heart and are forever moody, thinking of ways and means to retrieve it…."**

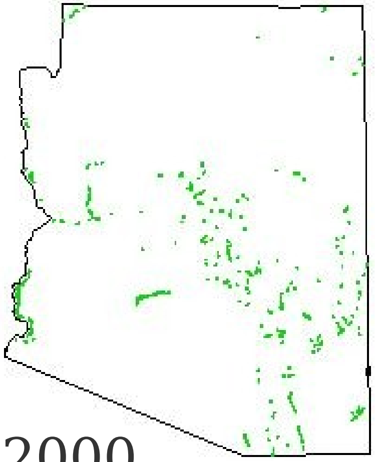
The San Pedro River



1850



1940



2000

- **Southwestern Riparian Areas have suffered great losses** *(Arizona, Nevada, New Mexico).*
- In Arizona, riparian ecosystems have declined by 90 percent.

# HISTORIC CONDITIONS

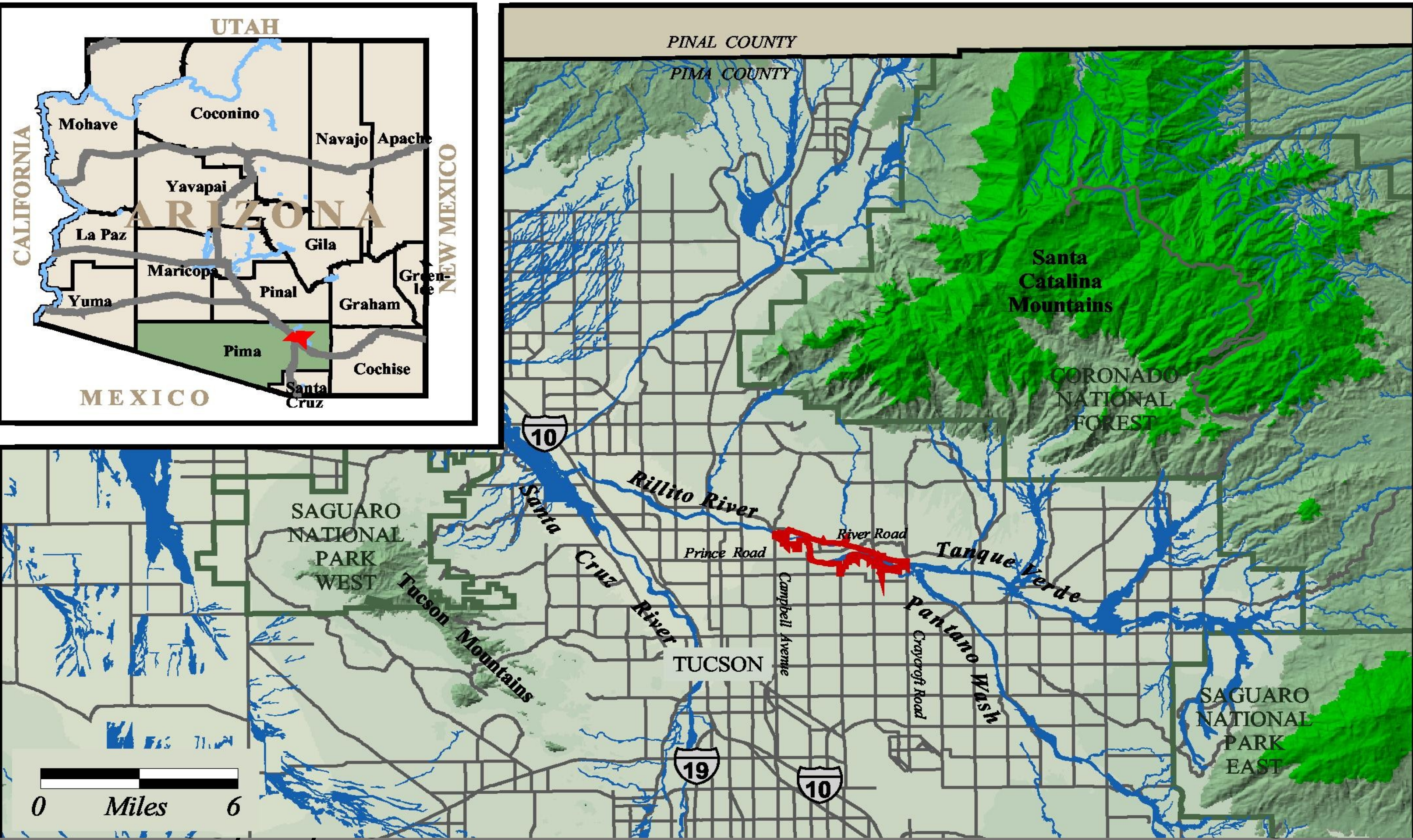
From a Personal Narrative of James Ohio Pattie (Pub. 1831).

*“We were much fatigued by the difficulty of getting through the high grass which covered the heavily timbered bottom”.*

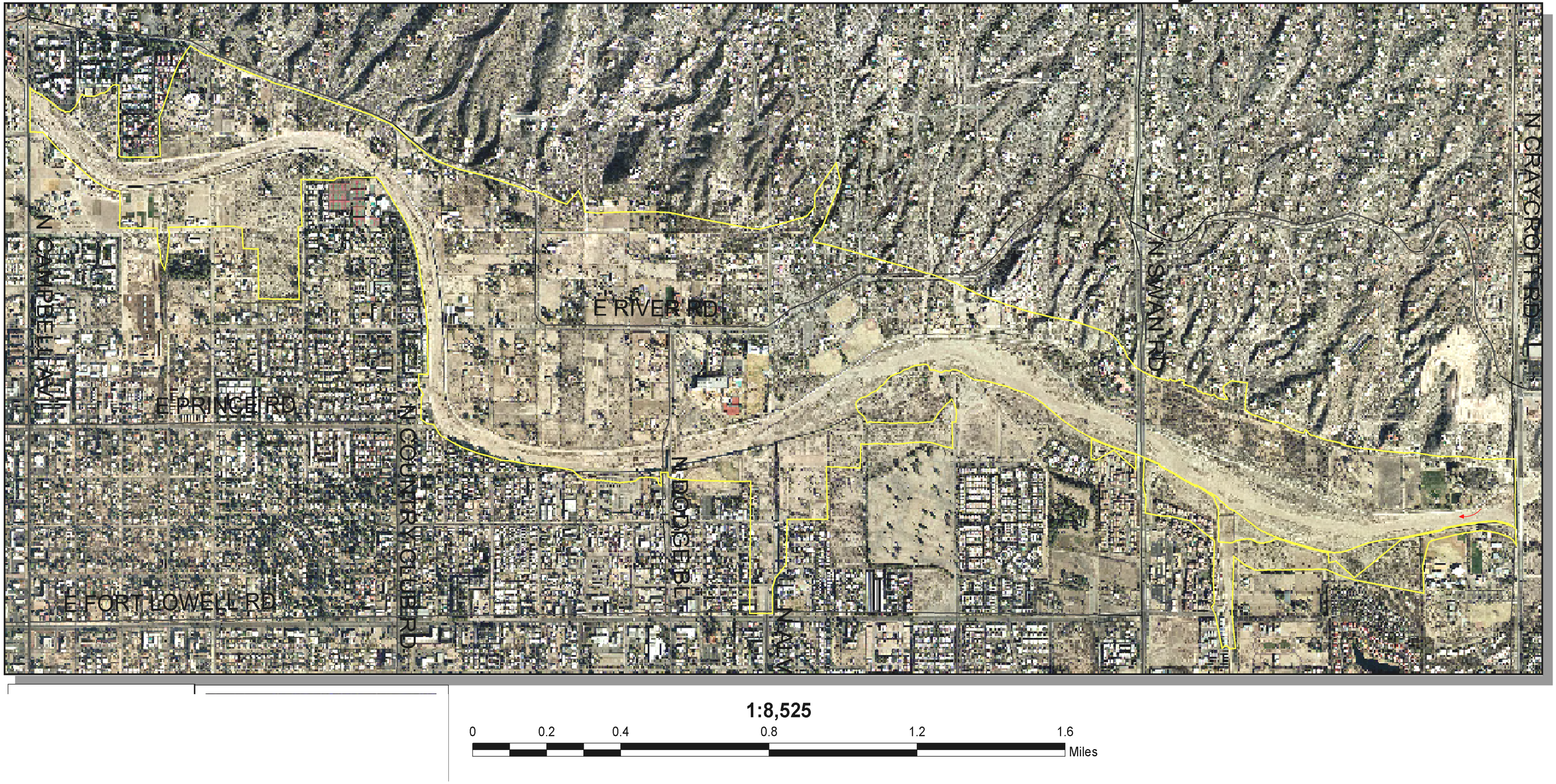
*“a thick tangle of grapevines and underbrush through which we crawled, sometimes on hands and knees”.*

On February 26, 1825 at the confluence of the Colorado and Gila River he

# RILLITO RIVER, PIMA COUNTY REGIONAL STUDY LOCATION


UTAH
CALIFORNIA
NEW MEXICO
MEXICO
ARIZONA
Mohave
Coconino
Navajo
Apache
Yavapai
La Paz
Gila
Maricopa
Pinal
Greenlee
Yuma
Graham
Pima
Cochise
Santa Cruz
PINAL COUNTY
PIMA COUNTY
Santa Catalina Mountains
CORONADO NATIONAL FOREST
10
Rillito River
Santa Cruz River
SAGUARO NATIONAL PARK WEST
Tucson Mountains
Prince Road
River Road
Tanque Verde
Campbell Avenue
Pantano Wash
Craycroft Road
TUCSON
19
10
SAGUARO NATIONAL PARK EAST
0
Miles
6

# El Rio Antiguo Vicinity
# Rillito River, Pima County


N CAMPBELL AV
E PRINCE RD
E FORT LOWELL RD
N COUNTRY CLUB RD
E RIVER RD
N DODGE BL
N ALV
N SWAN RD
N CRAYCROFT RD
1:8,525
0
0.2
0.4
0.8
1.2
1.6
Miles

# Model Development Conference

- State & Federal Agencies
- Sponsors
- Academia
- Corps staff

# Riverine Wetland and Riparian Functions

## Hydraulic/Hydrologic

- Characteristic Channel Dynamics
- Dynamic Surface Water Storage and Energy Dissipation
- Long Term Surface Water Storage
- Dynamic Subsurface Water Storage

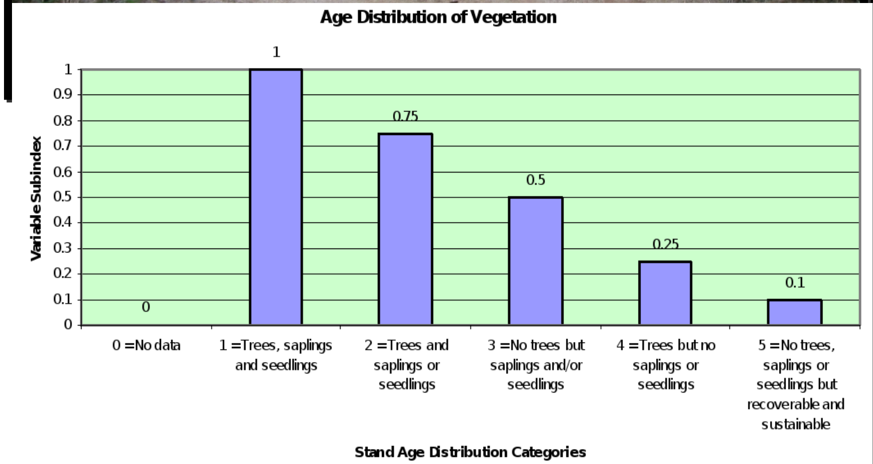
## Biogeochemical

- Nutrient Cycling
- Removal and/or Detention of Imported Elements
- Detention of Particulates

## Biologic

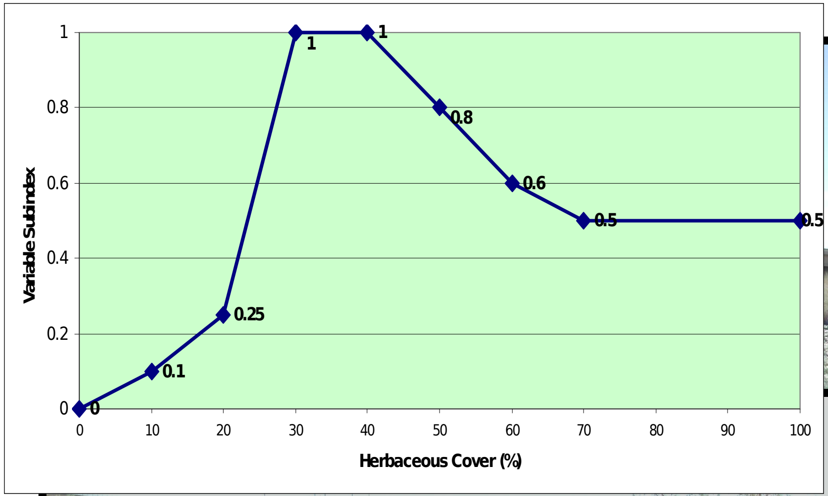
- Characteristic Plant Community
- Spatial Structure of Habitat
- Interspersion and Connectivity
- Protection Zone from Urban Encroachment

# Reference Site Sampling


Age Distribution of Vegetation
Variable Subindex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
0.75
0.5
0.25
0.1
0 =No data
1 =Trees, saplings and seedlings
2 =Trees and saplings or seedlings
3 =No trees but saplings and/or seedlings
4 =Trees but no saplings or seedlings
5 =No trees, saplings or seedlings but recoverable and sustainable
Stand Age Distribution Categories

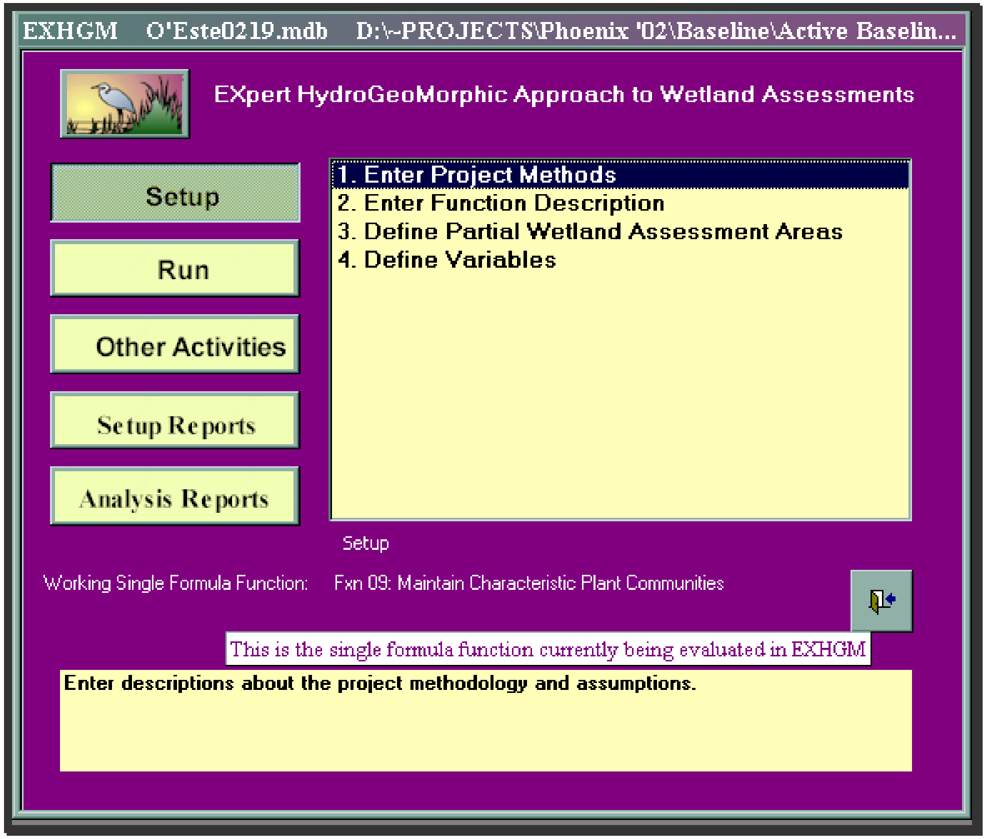
- Recommended by “Experts”
- Used to verify/set curves

# Study Area Sampling



# EXHGM Software

- Quantifies conditions using standard HGM techniques
- Incorporates a broad range of HGM regional guidebooks
- Processes large amounts of data quickly and efficiently
- Reduces computation time
- Adapts to regional variation
- Accommodates a variety



EXHGM O'Este0219.mdb D:\~PROJECTS\Phoenix '02\Baseline\Active Baselin...

EXpert HydroGeoMorphic Approach to Wetland Assessments

1. Enter Project Methods
2. Enter Function Description
3. Define Partial Wetland Assessment Areas
4. Define Variables

Setup

Working Single Formula Function: Fxn 09: Maintain Characteristic Plant Communities

This is the single formula function currently being evaluated in EXHGM

Enter descriptions about the project methodology and assumptions.

# Assessment of Ecosystem Conditions

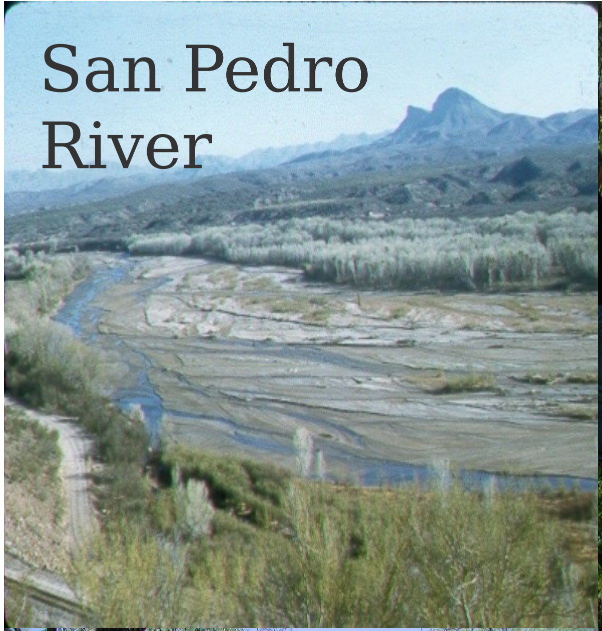
➲16 critical species of interest
To Pima County were identified with potential to occur in the study area

➲Four Pima County protected
native plant species were observed on the proposed project site.

➲Ecosystem restoration in the
study area is expected to benefit these species

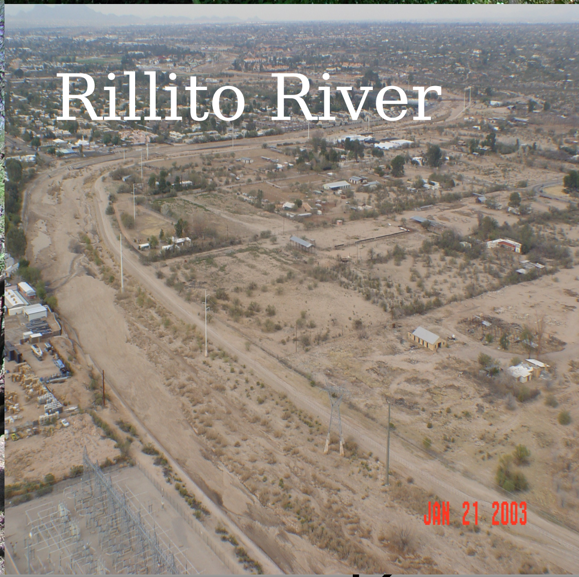
➲*-No federally T&E id'ed in study area – urban setting*

➲Riverine Functional health


San Pedro
River

Santa Cruz Rive
At Tumacacori

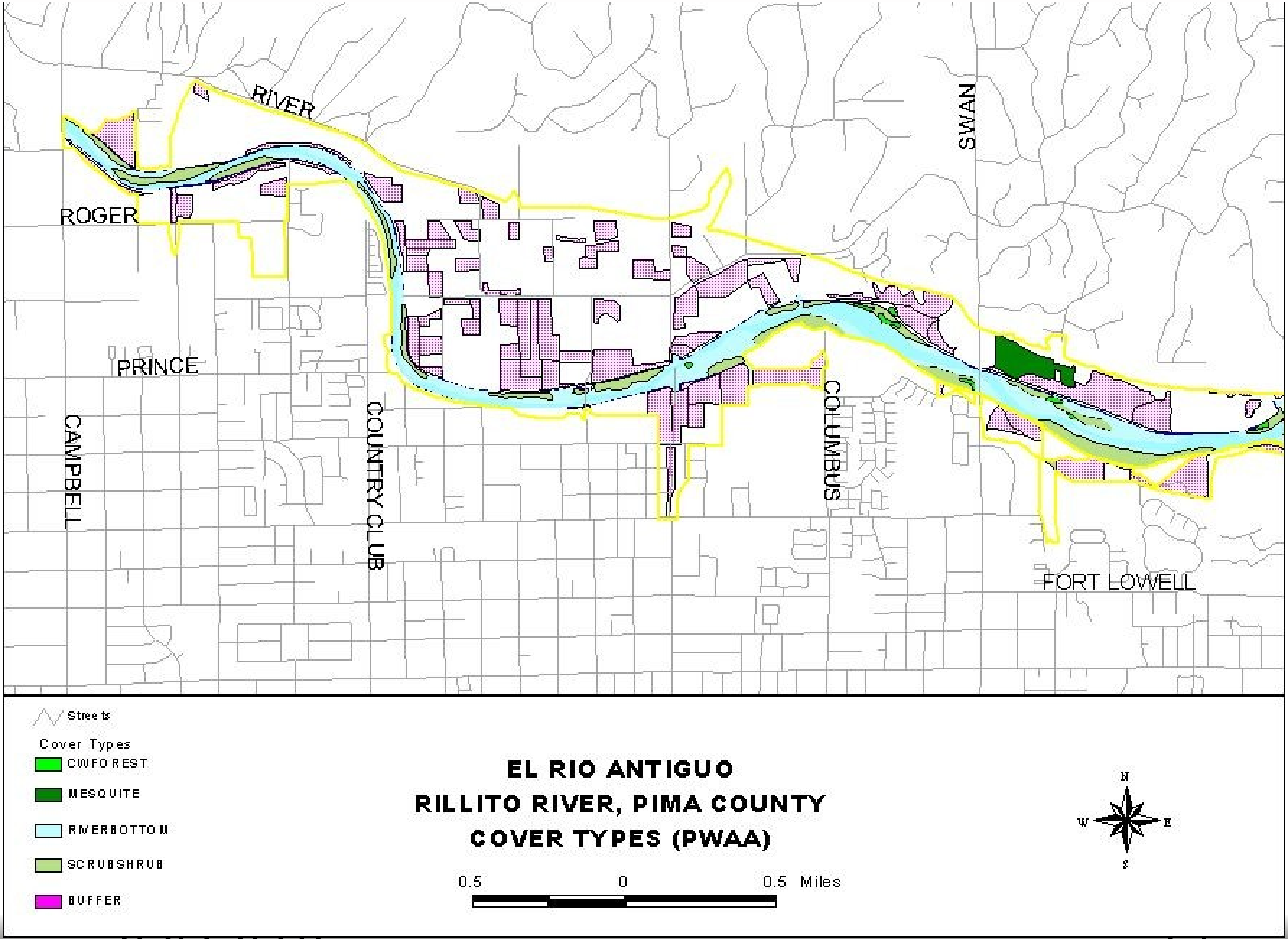
Tanque
Verde


Rillito River

# Water Resource Opportunities

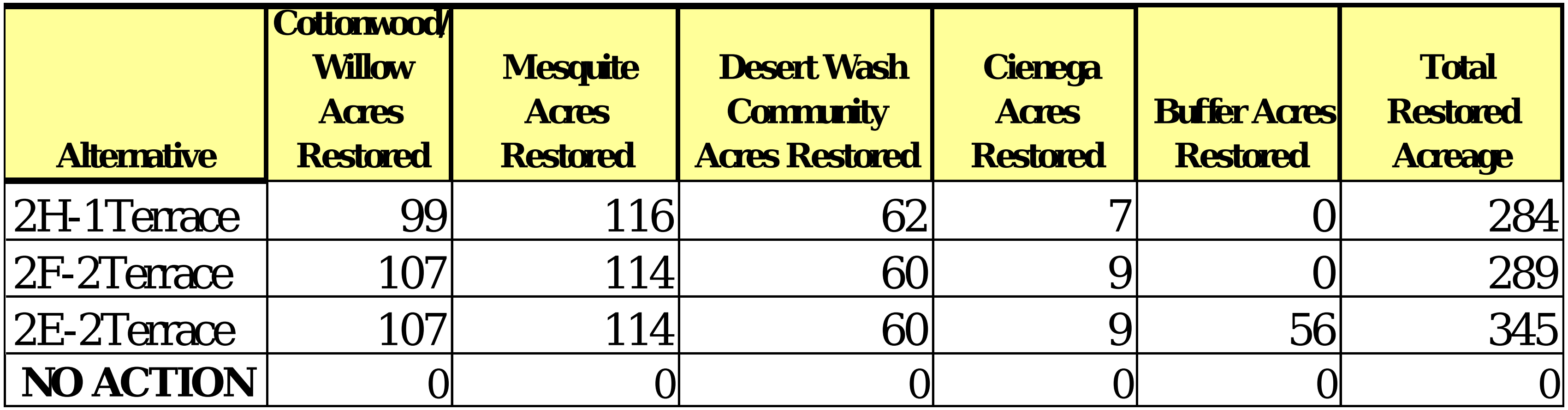
- **Potential water sources identified by Study Teams – USACE, Pima County**
  - Reclaimed water – 74,000 ac/ft per year
  - Rillito River - 10,135 ac/ft per year (flows an average of 11 times per year)
  - Tributaries – 2,844 ac/ft per year
  - Depth to Groundwater – 16 ft at Craycroft, 45 ft at Alvernon, 160 ft at Campbell Ave.
  - Storm drains (1411 cfs)
  - Outflows from study area – 3568 ac/ft per year

Rillito at Prince


RIVER
SWAN
ROGER
PRINCE
CAMPBELL
COUNTRY CLUB
COLUMBUS
FORT LOWELL
Streets
Cover Types
CWFOREST
MESQUITE
RIVERBOTTOM
SCRUBSHRUB
BUFFER
0.5
0
0.5 Miles
N
W
E
S

**EL RIO ANTIGUO**
**RILLITO RIVER, PIMA COUNTY**
**COVER TYPES (PWAA)**

| BUFFER | Existing | No Change | Restore |
|---|---|---|---|
|  | New | No Creation | Create |
| BASINS | Upstream | ALT 1H<br>UPBASINS-1 | ALT 1G<br>UPBASINS-4 |
|  | Downstream | ALT 1F<br>1-DWNBASINS-1 | ALT 1E<br>1-DWNBASINS-4 |
|  |  | ALT 1D<br>2-DWNBASINS-1 | ALT 1C<br>2-DWNBASINS-4 |
|  | All | ALT 1B<br>ALLBASINS-1 | ALT 1A<br>ALLBASINS-4 |
| IN-CHANNEL | Upstream Basin Alternatives with 3 Inflatable Barriers (+8 Gabions) and more extensive In-channel work<br>A = Finger Rock Wash work included<br>B = Finger Rock Wash work not included | ALT 3B<br>CHANBAR-1A | ALT 3A<br>CHANBAR-4A |
|  |  | ALT 3D<br>CHANBAR-1B | ALT 3C<br>CHANBAR-4B |
| TERRACES | 1 Set (x total ft) | ALT 2D<br>1-TERRACE-1 | ALT 2C<br>1-TERRACE-4 |
|  | 2 Sets (x total ft) | ALT 2B<br>2-TERRACE-1 | ALT 2A<br>2-TERRACE-4 |
| TERRACES & IN-CHANNEL | 1 Set (x total ft) & 12 Gabions | ALT 2H<br>1-TERRGAB-1 | ALT 2G<br>1-TERRGAB-4 |
|  | 2 Sets (x total ft) & 12 Gabions | ALT 2F<br>2-TERRGAB-1 | ALT 2E<br>1-TERRGAB-4 |

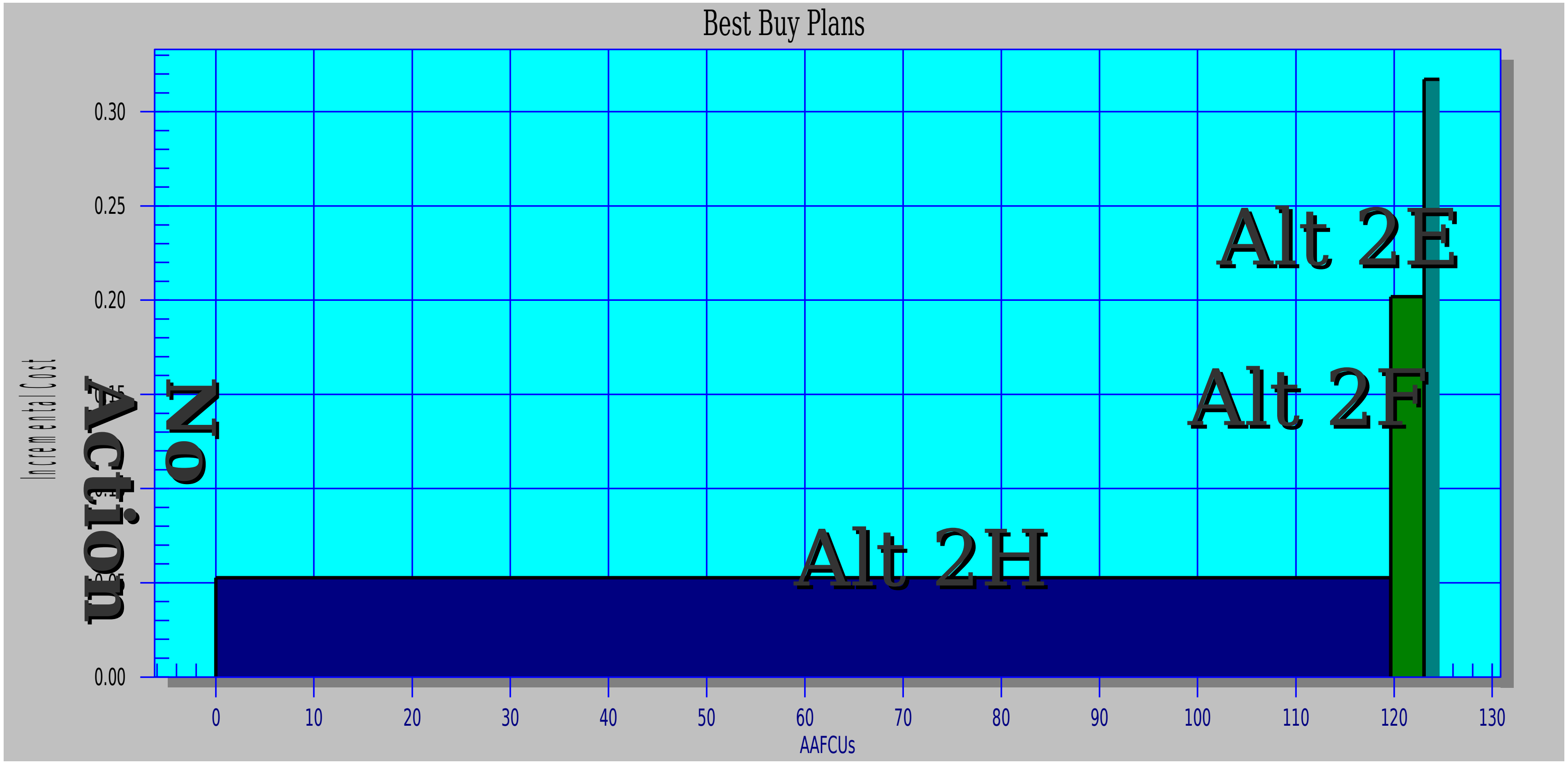


| Alternative | Cottonwood/ Willow Acres Restored | Mesquite Acres Restored | Desert Wash Community Acres Restored | Cienega Acres Restored | Buffer Acres Restored | Total Restored Acreage |
|---|---|---|---|---|---|---|
| 2H-1Terrace | 99 | 116 | 62 | 7 | 0 | 284 |
| 2F-2Terrace | 107 | 114 | 60 | 9 | 0 | 289 |
| 2E-2Terrace | 107 | 114 | 60 | 9 | 56 | 345 |
| **NO ACTION** | 0 | 0 | 0 | 0 | 0 | 0 |

- All three will reconnect Finger Rock with the Rillito with Mesquite Bosque Corridors, remove Dodge Bridge, and include water harvesting at tributary confluences and on the north side of the river east of Swan Rd.
- The No Action Alternative does not maintain any of the existing riparian vegetation.
- 107 acres of the channel will be improved incidentally.

# Economic Comparison

- The three remaining alternatives provided the most restoration in river function for the dollars invested over time.

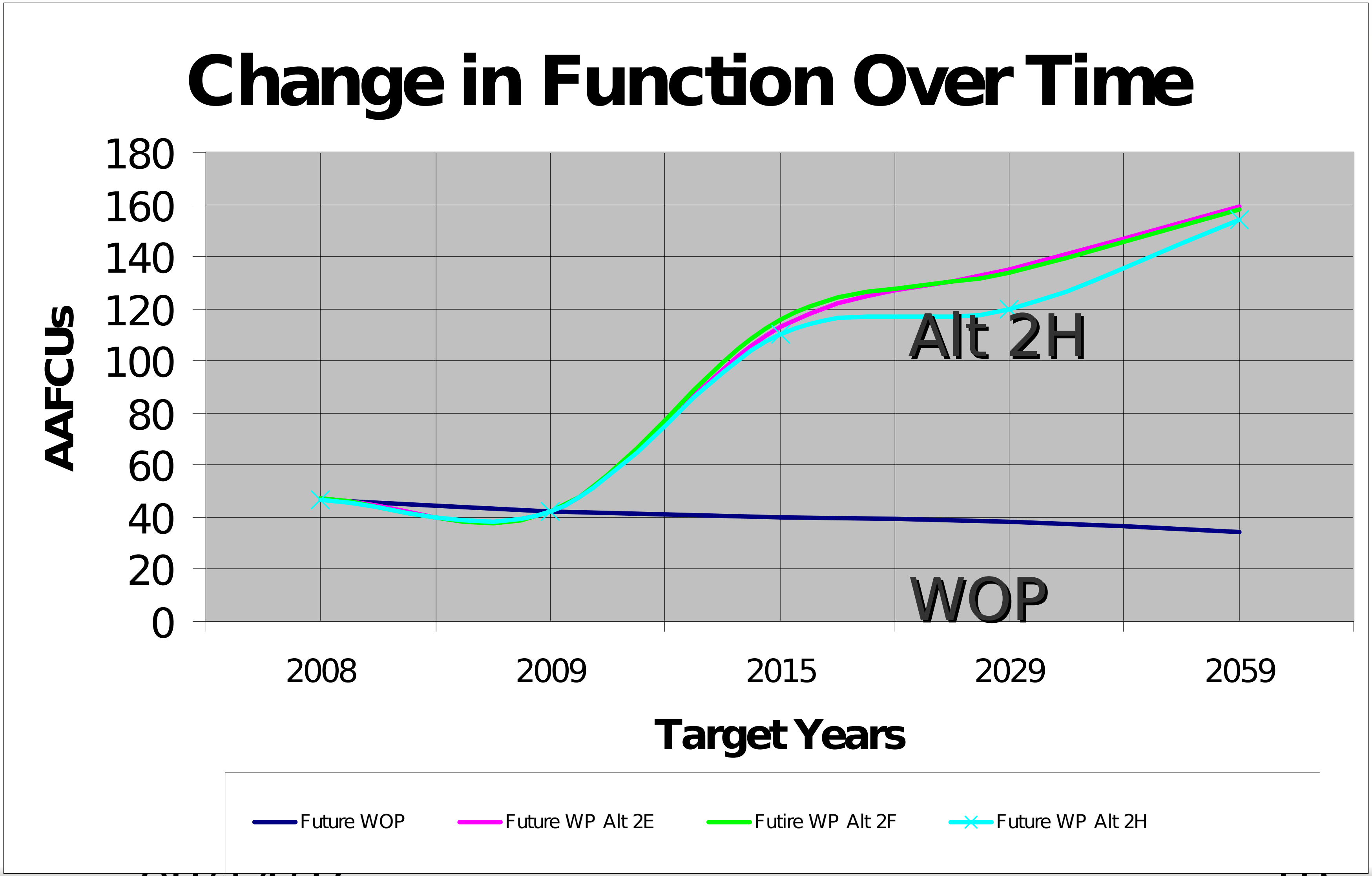


# F

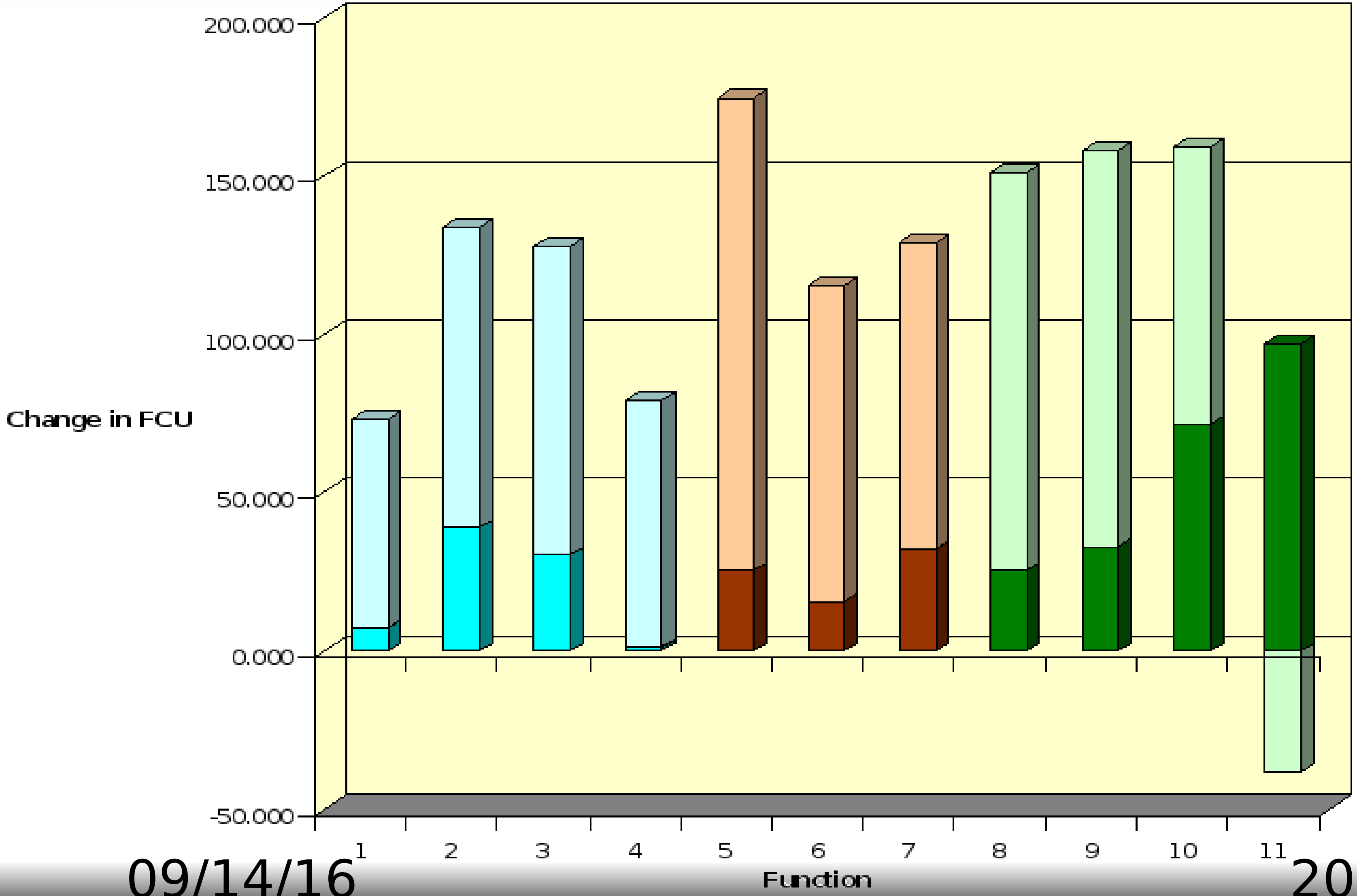
| Alternative | Net AAFCUs (Average Annual Functional Capacity Unit) | Cost Per Unit ($ 1000) | O&MRR Annual Costs ($M) |
|---|---|---|---|
| 2H | 120 | $53 | 1.26 |
| 2F | 123 | $60 | 1.30 |
| 2E | 125 | $57 | 1.30 |

- All final alternatives were cost effective
- All met study objectives
- All were close in functional outputs
- All had expected annual flood damage reduction benefits from restoration features of $560,000
- ALT 2H is least costly initially, has the least annual operations and maintenance costs and  and has fewer social impacts with no relocations of businesses or residences

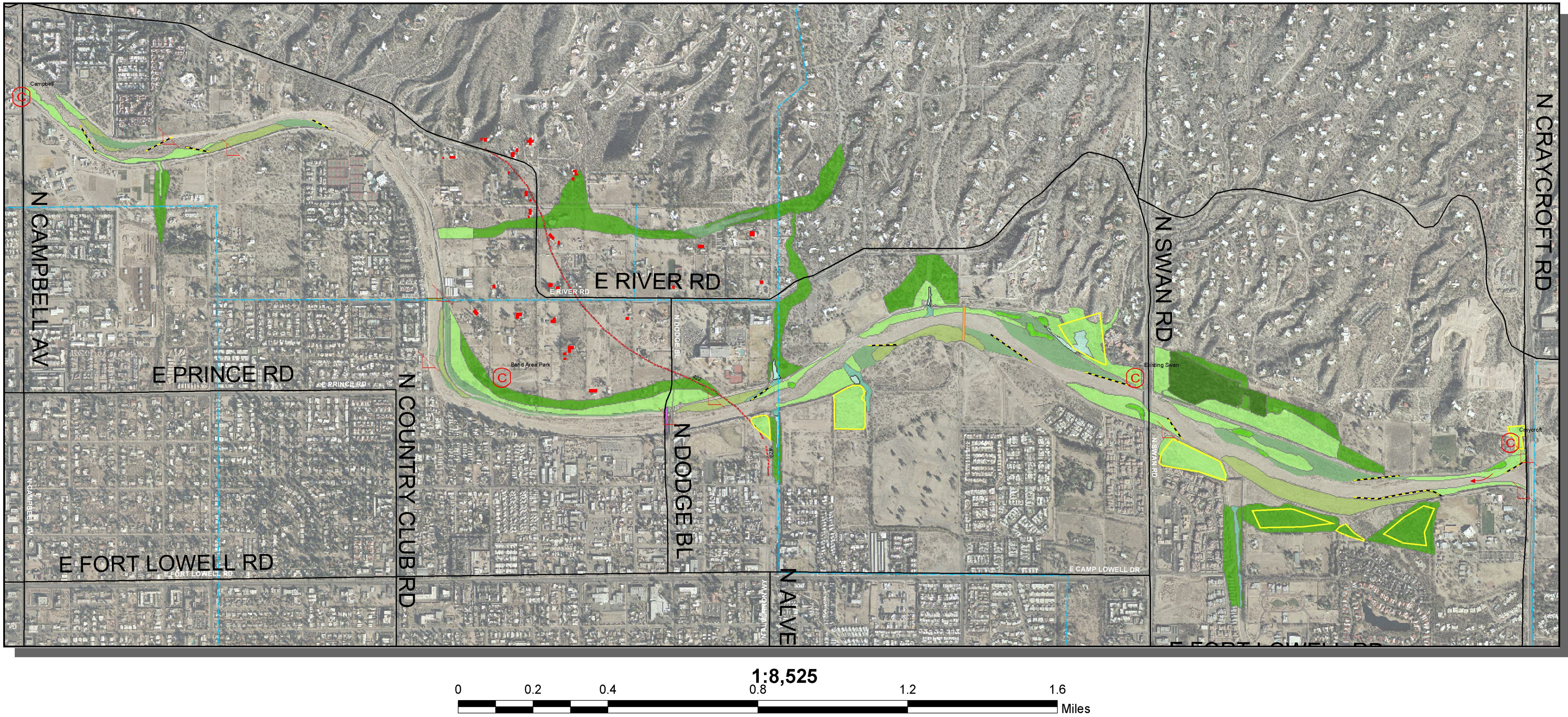
# WP Function vs. W/OP Function Trends



# Target Year 51 – Alt 2H vs WOP



# Alternative 2H


Campbell
N CAMPBELL AV
E PRINCE RD
E PRINCE RD
E FORT LOWELL RD
E FORT LOWELL RD
N COUNTRY CLUB RD
E RIVER RD
E RIVER RD
Bend Area Park
N DODGE BL
N ALVE
Existing Swan
N SWAN RD
N CRAYCROFT RD
Craycroft
E CAMP LOWELL DR
1:8,525
0
0.2
0.4
0.8
1.2
1.6
Miles

**Legend**

◺ Potential Ramp Locations
Ⓒ Comfort Station Locations
- - - Gabion Locations
-·-·- Reclaim Water Sources
☐ upstream basins
🟥 Historic Buildings

**NAME**

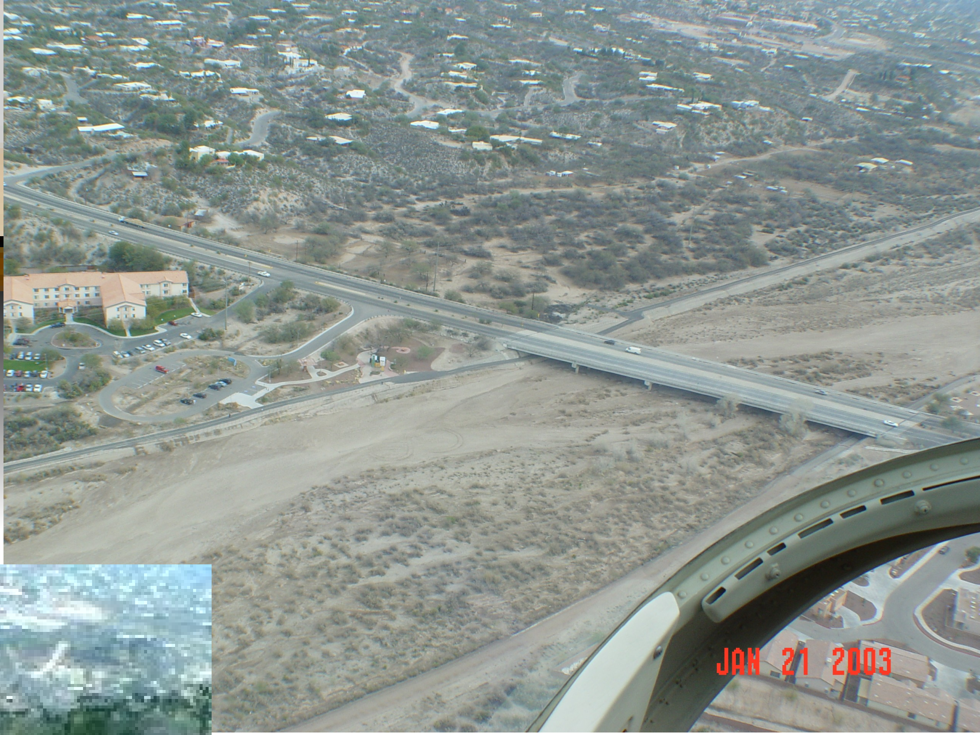
🟨 Bend Area Pedestrian
🟧 Columbus Pedestrian
🟪 Dodge
⬜ Existing Pedestrian
- - - River to Alvernon Realignment

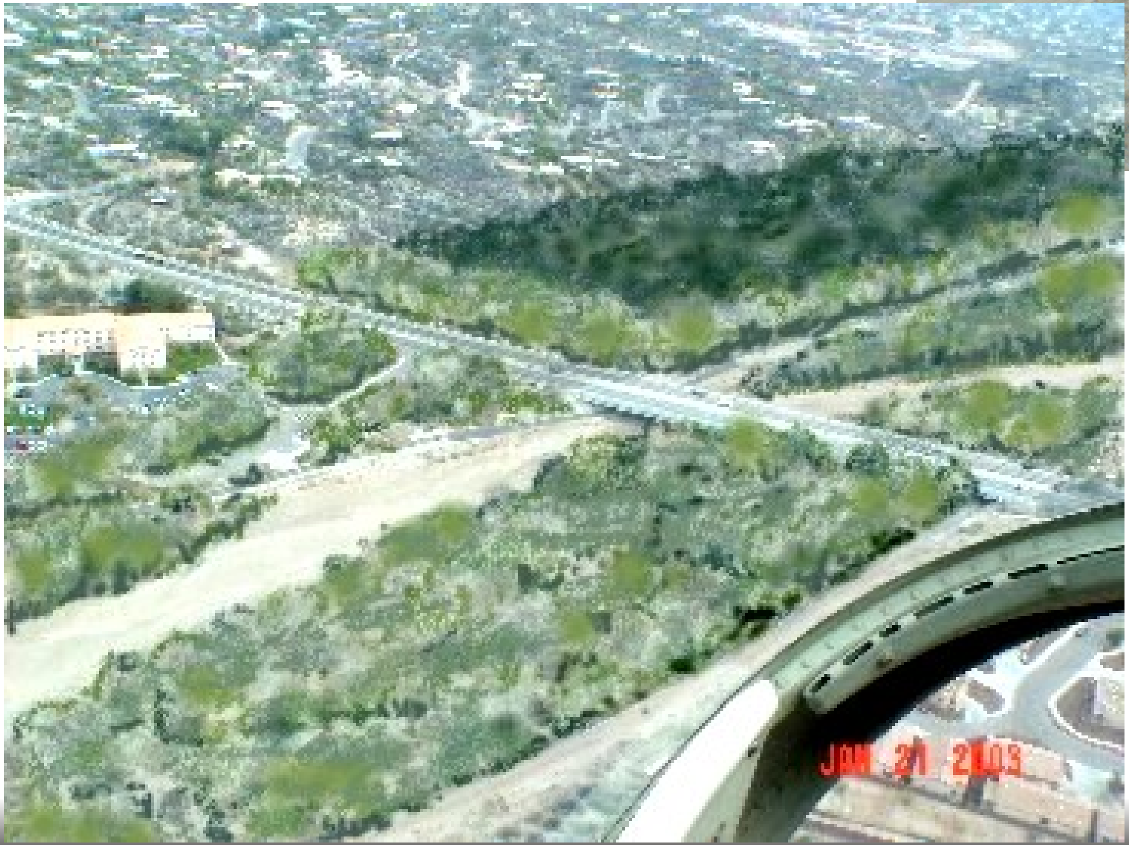
**RESTORED_C**

🟩 EXISTING CWFOREST
🟩 EXISTING MESQUITE
🟩 EXISTING RIVERBOTTOM
🟩 EXISTING SCRUBSHRUB
🟩 NEW CWFOREST
🟩 NEW MESQUITE
🟩 NEW RIVERBOTTOM
🟩 NEW SCRUBSHRUB

*PRIMARY FEATURES*
*1 set of terraces*
*8 upstream basins*
*12 gabions*
*Finger Rock Wash Riparian Corridors*
*RECREATION FEATURES*
*New ramp access to river*
*2 new pedestrian bridges*
*2 new comfort stations*
*Parking at Craycroft*

# Craycroft – Swan Foothills Water Harvesting Area

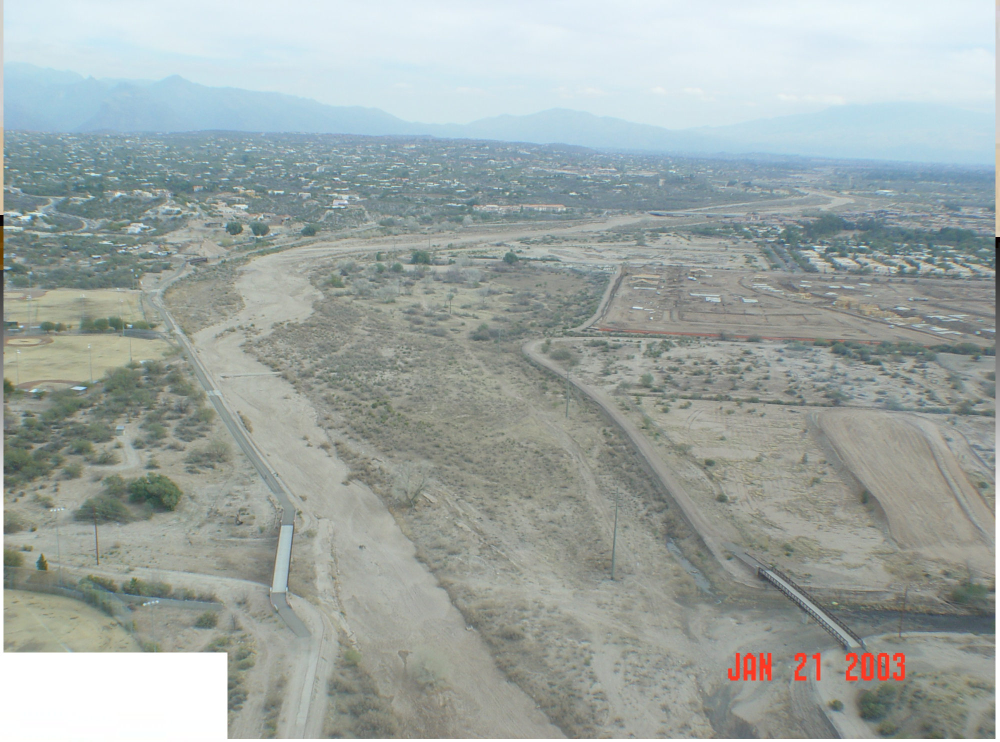




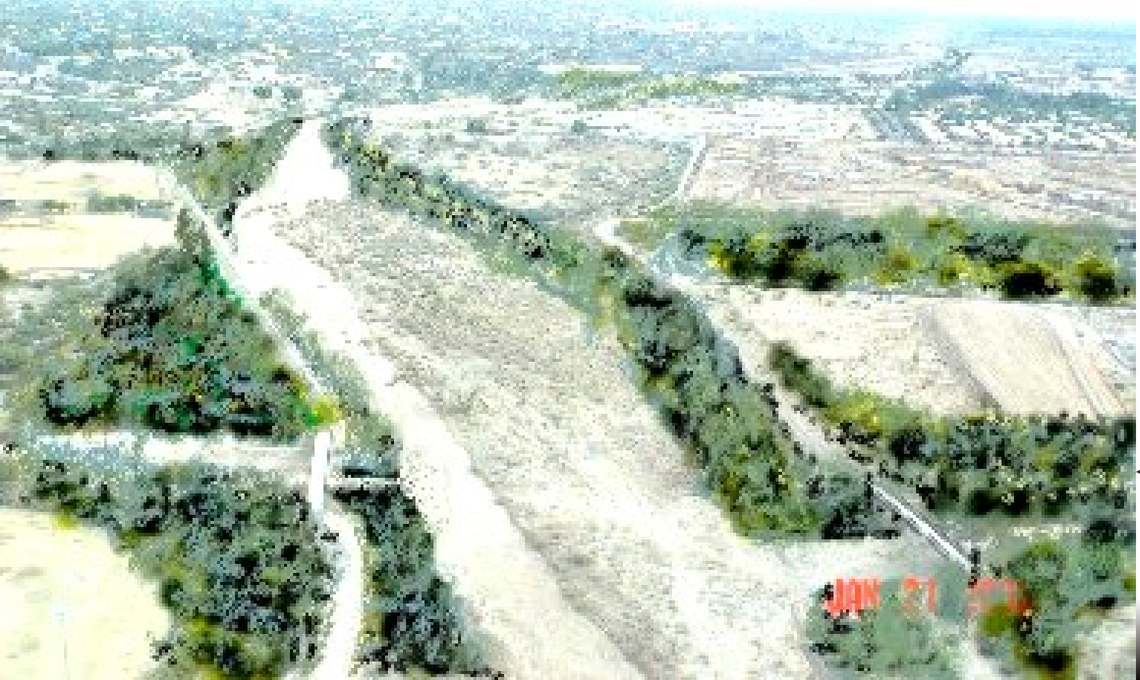
Existing

WP

# Over Dodge Road bridge looking east at Swan

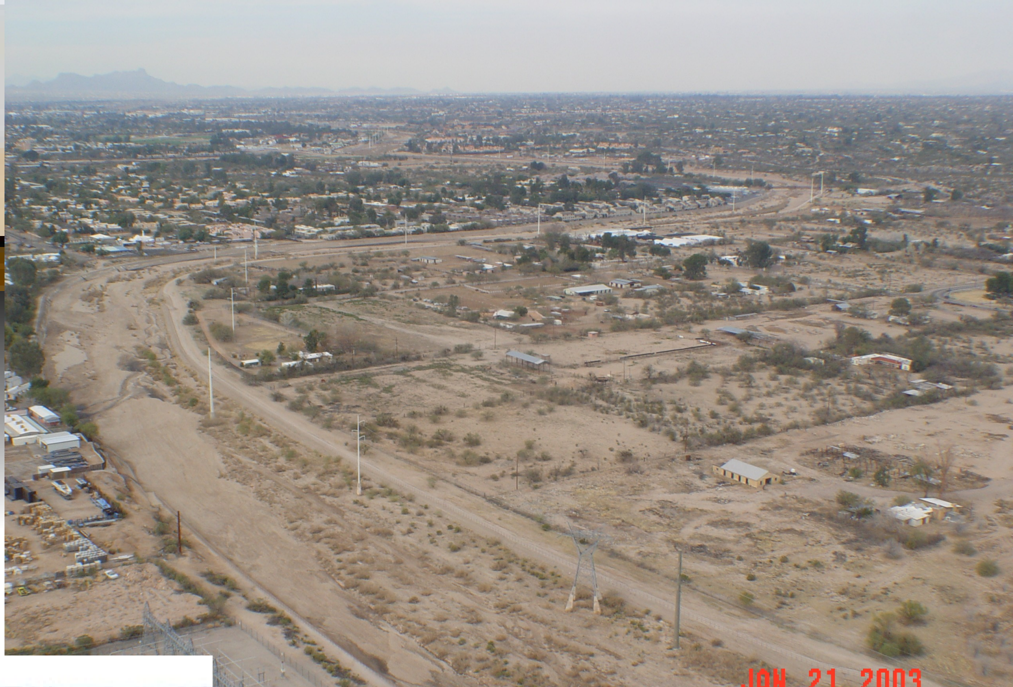


Existing

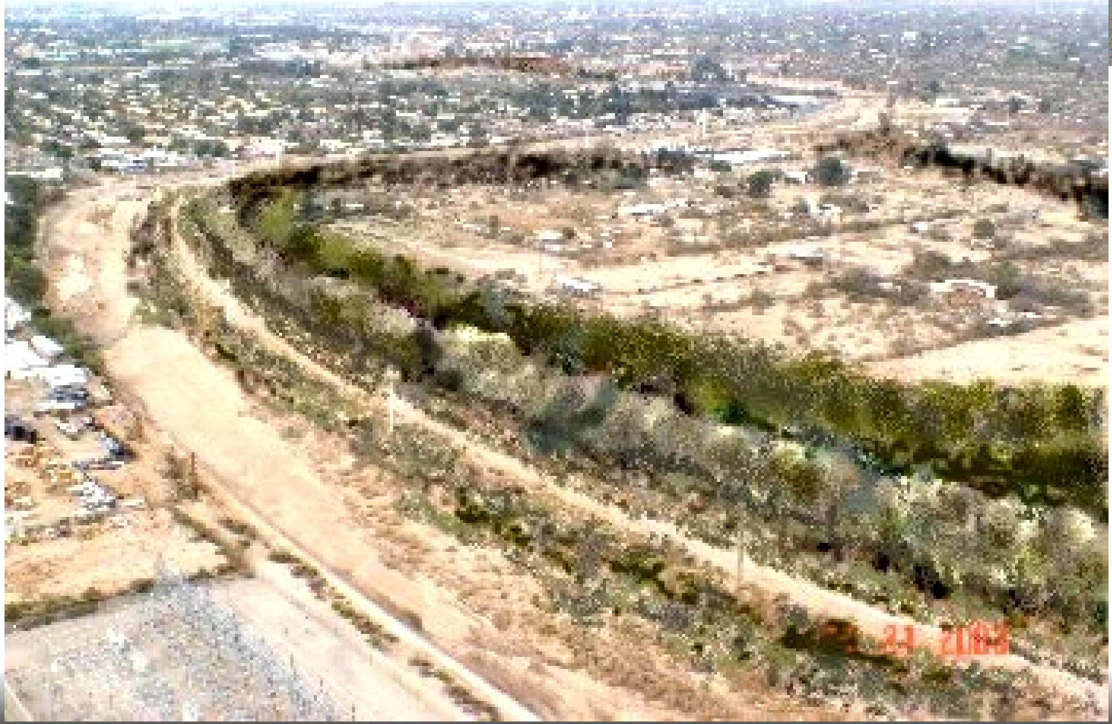


WP

# Over Dodge Road looking Northwest Bend area on

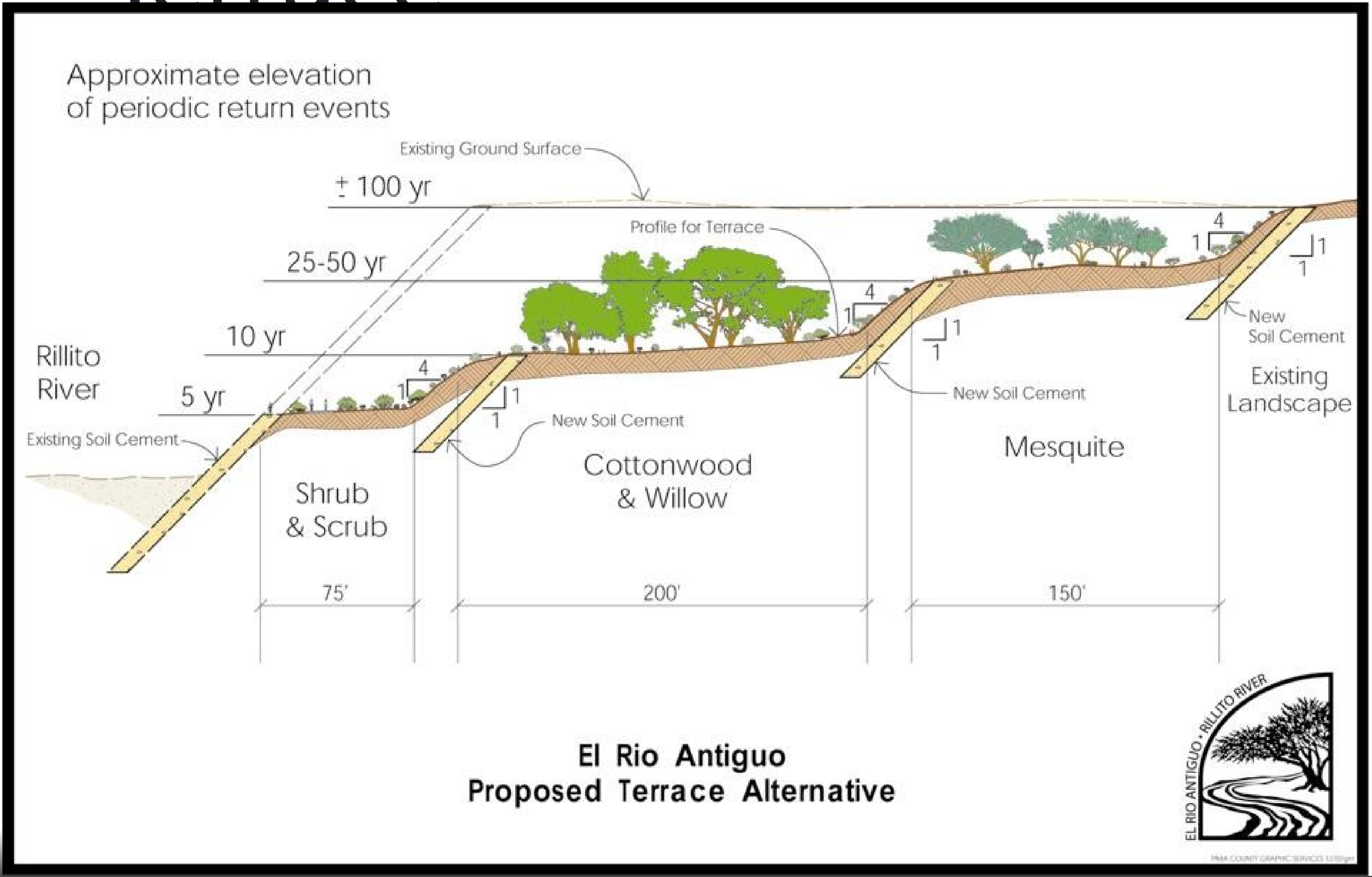


Existing

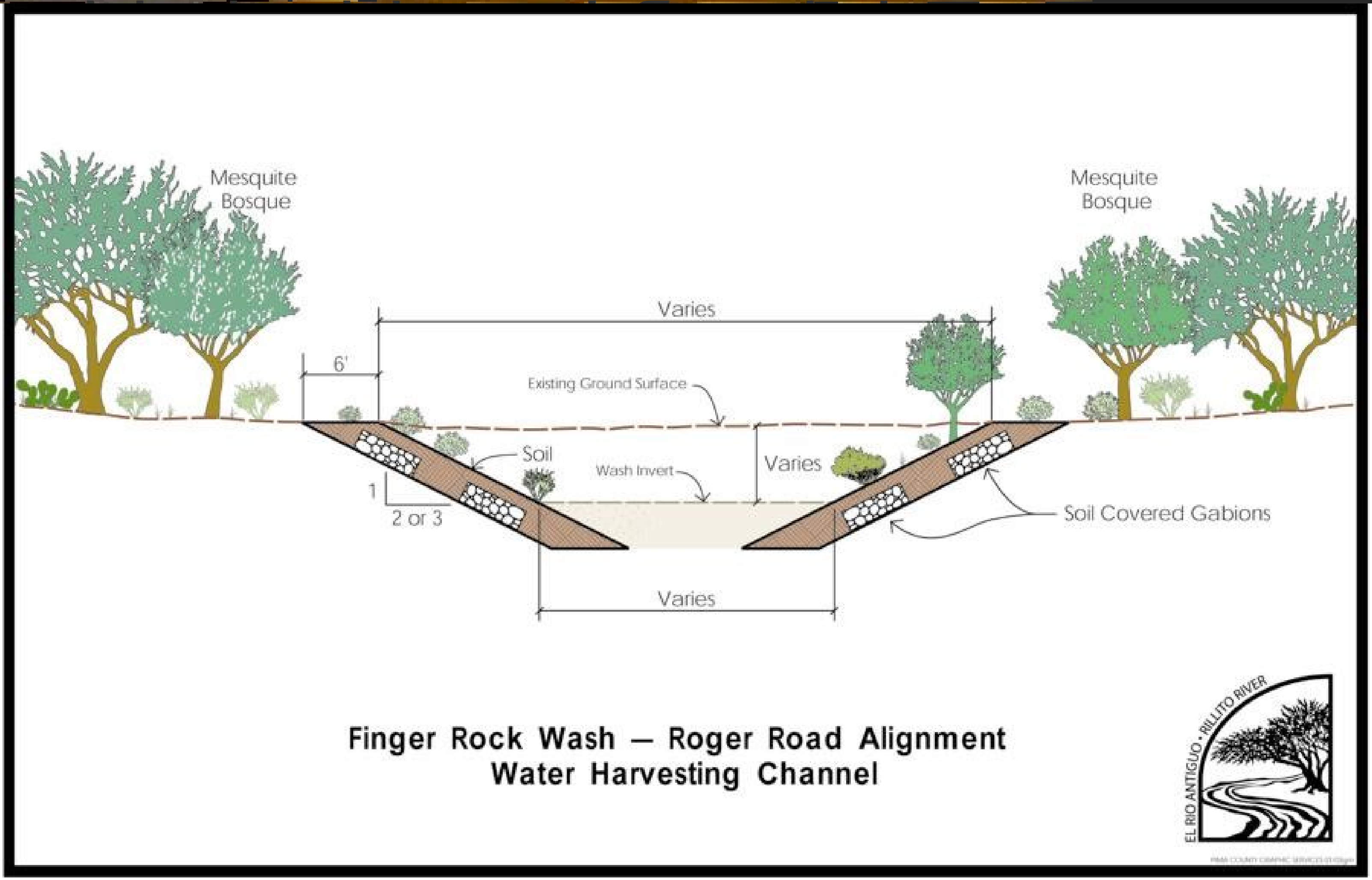


WP

# Typical X-Section of Terrace

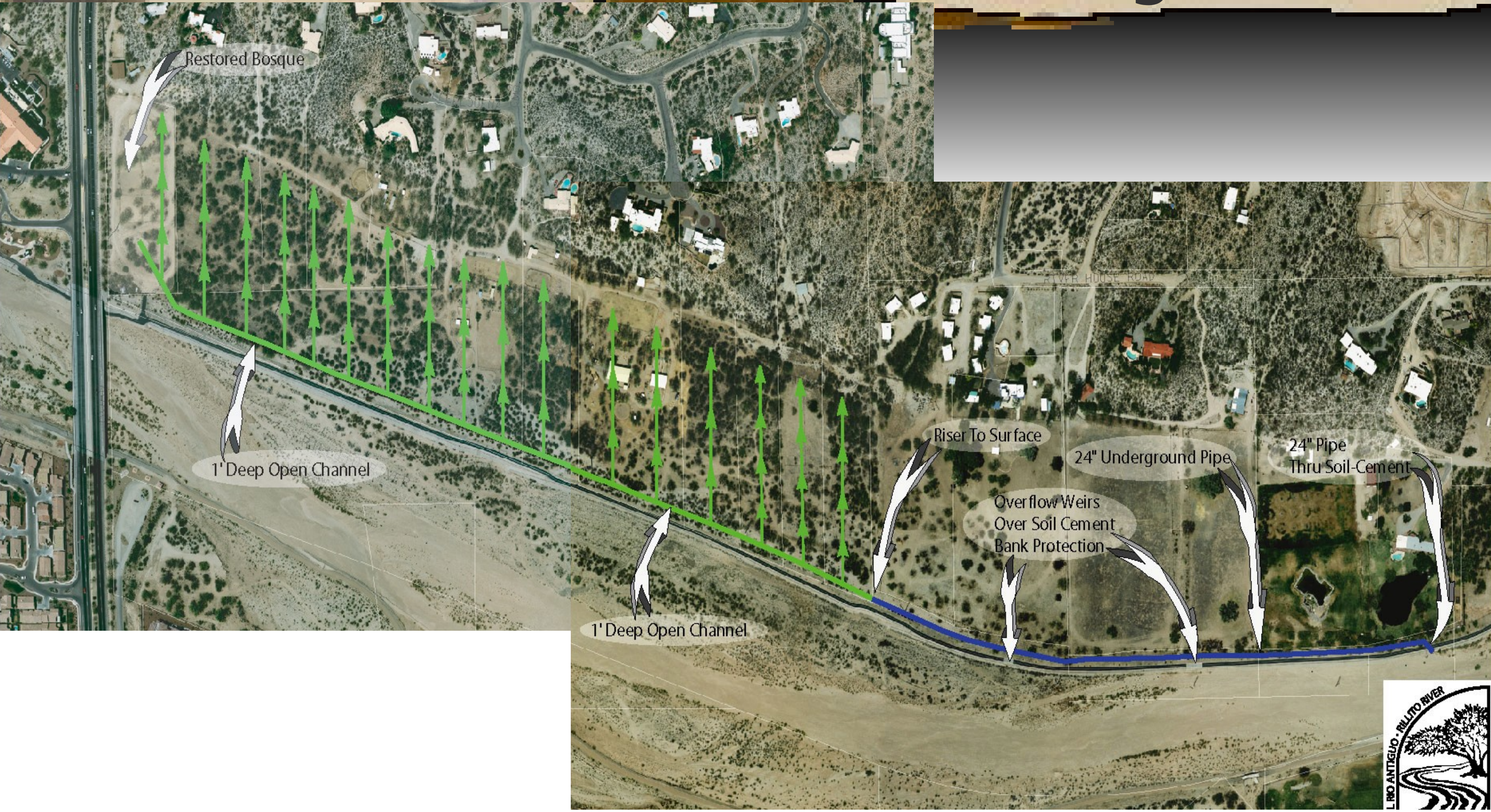

Approximate elevation of periodic return events
Existing Ground Surface
± 100 yr
Profile for Terrace
25-50 yr
10 yr
5 yr
Rillito River
Existing Soil Cement
4
1
1
1
New Soil Cement
New Soil Cement
New Soil Cement
Shrub & Scrub
Cottonwood & Willow
Mesquite
Existing Landscape
75'
200'
150'
El Rio Antiguo
Proposed Terrace Alternative
EL RIO ANTIGUO • RILLITO RIVER

# Water Harvesting Channels on Tributary


Mesquite Bosque
Mesquite Bosque
Varies
6'
Existing Ground Surface
Soil
Wash Invert
Varies
1
2 or 3
Soil Covered Gabions
Varies
EL RIO ANTIGUO • RILLITO RIVER

**Finger Rock Wash — Roger Road Alignment**
**Water Harvesting Channel**

# Craycroft-Swan Road foothills storm water harvesting


Restored Bosque
1' Deep Open Channel
1' Deep Open Channel
RIVER HOUSE ROAD
Riser To Surface
24" Underground Pipe
24" Pipe
Thru Soil-Cement
Overflow Weirs
Over Soil Cement
Bank Protection
RIO ANTIGUO - RILLITO RIVER

# ESTIMATED PROJECT COSTS

$65,000,000

## O & M Estimated Annual Costs

Annual O & M
$408,080

Associated Annual Cost of Water
$851,932

# Future Wish List for HGM/Functional Assessment

- Simplification of model/methodology
  - Fewer functions
  - Less reliance on expert opinion for forecasting
  - User friendly software
    - Graphic outputs
    - Outputs that do not need to be redone in excel
  - GIS compatibility – as you change alternatives, reflected in GIS